

CLAIMS

WHAT IS CLAIMED IS:

- 1 1. A method of treating an ischemic region of a patient, the method comprising:
2 positioning an ultrasonic transducer proximate to the ischemic region; and
3 applying ultrasonic energy at a frequency at or above one megahertz (MHz) from
4 said ultrasonic transducer to create a first thermal lesion in the ischemic region.
- 1 2. The method of Claim 1, wherein said ultrasonic energy is applied at a frequency
2 between 4 MHz and 15 MHz.
- 1 3. The method of Claim 1, further comprising:
2 repositioning said ultrasonic transducer; and
3 applying ultrasonic energy at a frequency greater than approximately one megahertz from
4 said ultrasonic transducer to create one or more second thermal lesions in the
5 myocardium.
- 1 4. The method of Claim 3, wherein at least one second thermal lesion is created in
2 the ischemic region adjacent said first thermal lesion.
- 1 5. The method of Claim 3, wherein at least one second thermal lesion is created in
2 myocardium adjacent said ischemic region.
- 1 6. The method of Claim 5, wherein at least one second thermal lesion is created in
2 the ischemic region of the myocardium adjacent said first thermal lesion.
- 1 7. The method of Claim 3, wherein said first thermal lesion and said one or more
2 second thermal lesions are created so as to have a gradient of sizes.
- 1 8. The method of Claim 1, further comprising controlling the temperature of said
2 transducer to be below approximately 80°C.
- 1 9. The method of Claim 8, wherein said ultrasonic transducer is connected to a
2 power source having a controllable duty cycle, and said temperature of said ultrasonic transducer
3 remains at or below 80° C by controlling said duty cycle.

1 10. The method of Claim 1, wherein said ultrasonic transducer is one of an array of
2 ultrasonic transducers, said method further comprises:

3 applying ultrasonic energy at a frequency greater than approximately one
4 megahertz from the one or more ultrasonic transducer in said array of ultrasonic
5 transducers to create one or more second thermal lesions in said myocardium.

1 11. The method of Claim 1, wherein said ultrasonic energy is applied so that said first
2 thermal lesion is located internal to the myocardium and distal from an endocardium and an
3 epicardium of said myocardium.

1 12. The method of Claim 11, further comprising applying ultrasonic energy at a
2 frequency greater than approximately one megahertz from said ultrasonic transducer to create
3 one or more second thermal lesions located internal to the myocardium and distal from the
4 endocardium and epicardium.

1 13. The method of Claim 1, wherein said ultrasonic transducer is inserted inside a
2 heart of the patient.

1 14. An apparatus for creating multiple thermal lesions in biological tissue, the
2 apparatus comprising:
3 a catheter;
4 an array of ultrasonic transducers mounted on a distal portion of said catheter;
5 a power source that provides energy through said catheter to said ultrasonic
6 transducers; and
7 a controller for controlling the energy provided to said ultrasonic transducers from
8 said power source.

1 15. The apparatus of Claim 14, wherein the ultrasonic transducers of the array are
2 each independently coupled to said power source and independently controlled by said
3 controller.

1 16. An apparatus for creating thermal lesions within biological tissue, the apparatus
2 comprising:
3 a catheter;

4 an ultrasonic transducer mounted on a distal end of said catheter, said ultrasonic
5 transducer having a shape that causes ultrasonic energy emanating from said transducer
6 to converge on a region beyond said transducer;

7 a power source that provides energy through said catheter to said ultrasonic
8 transducer; and

9 a controller for controlling the energy provided to said ultrasonic transducer from
10 said power source.

1 17. The apparatus of Claim 16, wherein said shape is a partial cylinder, is bowl-like,
2 or is hyperboloid-like.

1 18. The apparatus of Claim 16, further comprising one or more additional ultrasonic
2 transducers mounted on said distal end of said catheter.

1 19. The apparatus of Claim 18, wherein said additional transducers have a shape that
2 causes ultrasonic energy emanating from said additional transducers to converge in a region
3 beyond said transducer.

4 20. The apparatus of Claim 18, wherein one or more of said ultrasonic transducers are
5 independently coupled to said power source and independently controlled by said controller.